ECE 403

Senior Design II

Options Considered Document

9/23/09

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Introduction

The main purpose of our project is to test RFID tags, how they respond to changes in the weather conditions and how long they can work against extreme weather conditions. Also, alongside we also plan to build a mini-weather station of monitor weather and store it as a data entry on a daily basis.

Previous work:

Field Testing Of RFID tags (November 2004)

RFID antennas were used to monitor the cattle movement, and even though the cows moved pretty fast the sensors were able to record all the movement under a single entity (file).

Second Field Test (May 2005)

Ear RFID rags were implemented

Other work:

After this under the same team, the RFID tags were monitored after one week and so on and data was recorded to keep cattle counted which was successful. After a year, other field tests were performed and decent results were accomplished as the team came up with better RFID tags for cattle.

[Project by-Douglas Freeman, Kris Ringwohl, Mick Riesinger]

Other Work In 2006

HF RFID TAGS:

The same team worked on high frequency RFID tags, using the same ear clipping method and about 60 cows were successfully tagged.

Design Options

The Big Picture

This project requires building a fully functioning portable weather station to be used while testing RFID tags in different kinds of weather. The client wishes the station to be able to take accurate weather readings about every six seconds or so. Many different sensors and measuring devices could be used for this weather station to achieve the requirements.

Parameter for Weather Measurements: Weatherproof Circuit Board Casing

Our board or boards will most likely be sitting outside in these different weather conditions. If we choose to have our boards in these conditions, we will need to contain them in a weatherproof casing. For this to be effective, we need to make the casing sealable but easy to access for repairs or adjustments to our circuit board inside. The casing will also have to feature access to wired external sensors that will be positioned outside and near our circuit board.

Parameter for Weather Measurements: Temperature

We need to be able to take accurate temperature readings for weather testing. The design of this circuit depends on how we wish to measure the temperature. Depending on what type of sensor we use, we may need to have this sensor outside of our casing for the circuit board. If our circuit board is sitting outside in the same weather conditions as the RFID tags we are testing, we may be able to use a temperature sensor that sits inside our casing. As our designs progress, we will need to find out if our circuit will produce any heat which could possibly affect the accuracy of our temperature readings.

Possible Temperature Sensors

The sensor that we have looked at using is the TC77 SPI temperature sensor. This sensor can withstand temperatures from -55°C to 125°C when power is applied. It operates from 2.7 V to 5.5 V and has low power consumption. It converts the temperature data from the internal thermal sensing element as a 13-bit two’s compliment digital word. The price for this part is also cheap, listed at $1.22 per sensor.

Parameter for Weather Measurements: Humidity

Another temperature reading that we are required to make for our testing is humidity. There are many different sensors that we could possibly use for reading humidity. Most of these sensors are similar and won’t require much time spent on different compatible circuit designs. Again, we will need to address whether or not our sensor will need to be external of our circuit board casing, or if we can get an accurate humidity reading from inside our casing.

Possible Humidity Sensors

There are several possible humidity sensors we could utilize in our circuit design. Because of the varying climates that our testing can take place in, we would ideally want a sensor that can maintain performance in a wide temperature range. The sensor we found with the largest temperature range is the HS1101LF. This part can operate from -60°C to 140°C. This part will be simple to employ as the capacitance to frequency conversion can be done with a simple 555 timing circuit. This frequency is then fed to the PIC's T1_CLK. A possible problem with this sensor would be that the price of each is valued at $14.43.

If price becomes a problem, we can simply switch our design to include the HCH-1000-001 or HCH-1000-002. These sensors are Honeywell manufactured capacitive humidity sensors. They perform the same function as the HS1101LF except that they're operating temperatures have slightly less of a range from -40°C to 120°C and the humidity range is also slightly less than the first sensor mentioned. However, the price of these units cost between $5.81 and $5.94 respectively. The same circuit design idea can be used for any of these three sensors mentioned.

Parameter for Weather Measurements: Rainfall

There are only a few design options that we can choose from to get a rainfall measurement. The first and optimal design would be to use the already existing rain gauge that would be provided to us by our client/advisor. This gauge keeps a digital count of the amount of rain collected and can possibly be wired to our PIC instead of using the existing LCD screen. Choosing this option would be very wise because that equipment can get relatively expensive if we were to purchase another one and there is one already available for our use.

Another design option instead of using the existing rain gauge would be a circuit using a microphone to measure rainfall. This option would dramatically increase the design difficulty for we would have to compute an algorithm that could convert the amount of rainfall the microphone "hears" into an actual measurement. This option would be way too time consuming and would throw our design schedule off track.

Parameter for Weather Measurements: Atmospheric Pressure

Atmospheric pressure is another weather element that we are required to take measurements of. There are a wide variety of sensors for this measurement requirement. The sensors are very similar, so with almost any sensor we choose to use, the sensor can still operate effectively while encased with our circuit board. This will help increase our simplicity for circuit design if we have one more sensor that does not have to be external and exposed to the elements.

Possible Atmospheric Pressure Sensors

We are looking at using the MPX4115A series of pressure sensors for this measurement requirement. This series features six different sensors that use several different package options. We will have an easier time designing our circuit board with this variety of different packages, depending how and where we need the sensor to fit on the board. The operating temperature values range from -40°C to 125°C and therefore should be adequate for use in our varying climate of testing. The

operating pressure for these sensors ranges from 15 to 115 kPa. The supply voltage required ranges from 4.85V to 5.35V and the sensor gives an output voltage of 0 to 4.8VDC. The price for these sensors runs around $10. A weather station is one of the perfect application examples for this series of atmospheric pressure sensors.

Parameter for Weather Measurements: Wind Speed

There are several design options for us to consider for wind speed measurements. One option is to purchase and build an anemometer and connect it to our circuit. This would be the easiest option for us. Another option was suggested by our advisor to build a circuit that measures wind speed by the use of two thermistors. This option is a more creative approach but it could greatly increase the difficulty of our project. It would require the two thermistors to be out in the elements and outside of our casing. After some investigation, this could require a fairly complicated circuit which may not be able to be tied into our main PIC. This option could pose problems but we could use it to show a non-traditional approach to measuring wind speed.

Possible PIC's

The PIC proposed by our advisor to use for our circuit is the PIC18F4620. This is the same PIC used in our boards for ECE 376 Embedded Systems. This PIC was proposed to us because we already have familiarity with the functionality and programming of this PIC. With proper planning and circuit design, we may be able to use just one PIC for our circuit board. This would be the best case scenario so we don't have to worry about multiple boards and multiple applications transferring data to our weather station observation computer.

Using the PIC18F4620 as our microcontroller will also be cost friendly for us because of its $8 price tag. There are also three different packages for this PIC for us to choose from, depending on what our design requires to maximize trace efficiency on our PCB. The operating temperature also meets our requirements as it functions from -40°C to 85°C.

While using this PIC in ECE 376, we already know that it can be hooked up to a serial port. This is very useful information since it will be sending us a constant flow of information during our testing.

Wireless Possibility

During our research, we have come across a smaller, yet similar weather station circuit that could broadcast some of its information wirelessly. This similar circuit used a transmitter with its temperature sensor so that it could be placed within a 25 meter radius of the receive circuit. This idea could be used for our purpose of having our main microcontroller inside our work station and out of the elements. We may find this approach to be too complicated to use, but it could turn out to be a great asset to our testing if we can have several of our sensors wireless and able to move freely of our microcontroller.

Budget:

We are planning to design a miniature weather station. We going to start with mounting individual sensors in each bread board and we will test each and every sensor for PIC compatibility. When we done with the testing we will be mounting everything on one PCB. Prior to our final shot we will be will making some prototypes. Therefore we need to order at least 5 PICS for one sensor and 7 of each sensor.

Part	Cost/Unit	Quantity	Total Cost	Digikey part #	Notes
MPX 4115A	10.34	7	72.38	MPX4115A-ND	Pressure sensor
TC77	1	7	7	TC77-5.0MOA-ND	Temperature sensor
HCH-1000-001	5.81	7	40.67	480 – 2903 – ND	Humidity sensor
Themistor	12.18	2	24.36	KCPTC1-KIT	
PIC 18F452	6.79	5	33.95	PIC18F452T-I/L	Micro controller
PIC 16C781	4.92	5	24.6	PIC16C781-I/SO-ND	Micro controller
PIC 16F84AP	4.01	5	20.05	PIC16F84A-04E/P-ND	Micro controller
Rain Wise	75.00	1	75		It will be used to collect and measure rainfall.
RX+TX433	12.50	5	62.5		wireless modules
NE555N	1.00	5	5	NE555NFS-ND	Programmable Timers and Oscillators
HCT4060	.76	5	3.8	296-9280-5-ND	Divider
Miscellaneous Hardware			100		Includes : capacitor, resistors, diodes, clamps

Parts Shipping, Misc.			15		

Total Cost: 484.00

Total Budget Requested: 500

Timeline:

Name	**Weeks**	**Who**
Requirements Capture meeting	2	All
Requirements Capture Document	2	All
>>>Req Cap Doc: Intro, Requirements, Summary	4	
Options Considered	4, 5	All
>>>Design Options	4, 5	Dan
>>> Introduction, Previous work, Summary	4, 5	Div
>>> budgets timeline	4, 5	Ashish
Practice assembling the PIC kit	5	All
Order Parts	6	Divyanshu
Make Schematic in Multisim	6	Ashish
Program PIC	7, 8, 9	Dan, Ashish
Breadboard PIC (w/o sensors)	8, 9	All

Interface w/ sensors	10, 11, 12	All
>>> Sensors	10, 11, 12	Divyanshu
>>> PIC	10, 11, 12	Dan, Ashish
Progress Report: Each will make individual part, then compile	12	All
>>> Progress on temperature sensor	12	Ashish
>>> Progress on humidity sensor	12	Divyanshu
>>>Progress on pressure sensor		Dan
>>>Progress on anemometer	12	Ashish
>>> Progress on PIC	12	Dan, Ashish
>>> Progress on Rain gauge	12	Divyanshu
>>>progress on wireless kit	13	Dan, Div
Revise Schematic in Multisim	14, 15	Ashish
Start PCB layout in Ultiboard	14, 15	Ashish, Dan
Prepare for presentation	15	All
Finalize PCB layout (Ultiboard)	15	Ashish, Dan
Presentations, end of semester	16	All

Week 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
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Summary:

Basically, we have shown above that many parameters of the weather can be measured, basically we plan to start off with a basic prototype involving the different pressure sensors connected to the micro-processor which in-turn will be linked to our computer to record data. After we come up with a successful working prototype, we plan to make it wireless and eventually build up a mini-whether station. Of course all this is done alongside the fact that we will be mo monitoring the progress on the RFID tags and how they respond to the different weather conditions. Another good thing about the whole project is that if successful, it is going to be a very economical project from a potential client’s point of view.